OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

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OXFORD AQA INTERNATIONAL A-LEVEL

CHEMISTRY (9620)

Unit 1: Inorganic 1 and Physical 1

Thursday 18 May 2017 Morning Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- the Periodic Table/Data Sheet, provided as an insert
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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Answer **all** questions in the spaces provided.

0 1 . 1 Complete the electron configuration for the aluminium ion, Al^{3+}

[1 mark]

$1s^2$ _____

0 1 . 2 Write an equation, including state symbols, to represent the process for which the energy change is the second ionisation energy of aluminium.

[1 mark]

_____

0 1 . 3 Explain why the second ionisation energy of aluminium is greater than the first ionisation energy of aluminium.

[1 mark]

_____

_____

0 1 . 4 An element, **Z,** in Period 2 of the Periodic Table has the successive ionisation energies shown in **Table 1**.

Table 1

	First	Second	Third	Fourth	Fifth
Ionisation energy / kJ mol^{-1}	1090	2350	4610	6220	37 800

Choose the correct identity of the Period 2 element **Z**.
Tick (✓) the correct box.

[1 mark]

Boron ☐

Carbon ☐

Nitrogen ☐

Silicon ☐

4

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0 2 The abundance of each isotope in a time of flight (TOF) mass spectrum of a sample of germanium is shown in **Table 2**.

Table 2

m/z	70	72	74
Abundance (%)	24.4	32.4	43.2

0 2 . 1 Give the formula of the ion that will reach the detector first.

[1 mark]

_____

0 2 . 2 Use the data in **Table 2** to calculate the relative atomic mass of this sample of germanium.

Give your answer to one decimal place.

[2 marks]

Relative atomic mass = _____

0 2 . 3 Explain how the abundance of each isotope is determined in a TOF mass spectrometer.

[2 marks]

_____

_____

_____

_____

_____

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0 2 . 4 Calculate the mass, in kg, of one atom of ^{72}Ge
The Avogadro constant = 6.02×10^{23} mol^{-1}.
Give your answer to the appropriate number of significant figures.

[2 marks]

Mass = _____ kg

0 2 . 5 In a TOF mass spectrometer, the ions are accelerated to the same kinetic energy (KE).

$KE = \frac{1}{2}mv^2$ where m = mass (kg) and v = velocity (m s^{-1})

$v = \frac{d}{t}$ where d = distance (m) and t = time (s)

A $^{72}Ge^+$ ion is accelerated to a kinetic energy of 3.98×10^{-16} J as it travels down the flight tube that is 3.00 m long.

Calculate the time taken for the $^{72}Ge^+$ ion to reach the detector.
Use your answer to Question **02.4** in your calculation.

[3 marks]

Time = _____ s

10

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0 3 A student is given three white solids, **A, B** and **C**. Each solid is thought to be one of these compounds:

magnesium carbonate, magnesium hydroxide, barium hydroxide, barium sulfate

The student carries out two tests on each solid to try to identify them.

Test 1 Add distilled water to a sample of the solid and stir.

Test 2 Add dilute hydrochloric acid to a sample of the solid.

Table 3 shows the results.

Table 3

Test	Solid	Result
1	**A**	Colourless solution forms
	B	No visible change, white solid remains
	C	No visible change, white solid remains
2	**A**	Colourless solution forms
	B	No visible change, white solid remains
	C	Effervescence and colourless solution forms

0 3 . 1 Use the results from **Test 1** to identify solid **A**.
Write an equation for the reaction of **A** in **Test 2**.

[2 marks]

Identity of **A** _____

Equation for **Test 2**

_____

0 3 . 2 The student deduced that solid **B** was magnesium carbonate because it is insoluble in water.

Give a reason why this deduction is **not** correct.
Suggest the identity of **B**.

[2 marks]

Reason _____

Identity of **B** _____

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0 3 . 3 Deduce the formula of each of the products responsible for the observations when **Test 2** is carried out on solid **C**.

[2 marks]

6

Turn over for the next question

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0 4 A molecule of AsF_5 can react with two molecules of ClF as shown in the equation.

$$AsF_5 + 2ClF \longrightarrow AsF_6^- + FCl_2^+$$

Use your knowledge of electron pair repulsion to draw the shape of the AsF_6^- ion and the shape of the FCl_2^+ ion.

Include any lone pairs of electrons that influence the shapes.

Predict the bond angle in the FCl_2^+ ion.

Name the shapes made by the atoms in the AsF_6^- ion and by the atoms in the FCl_2^+ ion.

[5 marks]

	AsF_6^-	**FCl_2^+**
Shape		
Bond angle		
Name		

5

Turn over ►

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0 5 Sodium chlorate(V) decomposes on heating to form sodium chloride and oxygen as shown in the equation.

$$2NaClO_3(s) \longrightarrow 2NaCl(s) + 3O_2(g)$$

0 5 . 1 Thermal decomposition of a sample of sodium chlorate(V) produced 0.835 g of sodium chloride.

Calculate the amount, in moles, of sodium chloride in 0.835 g.
Give your answer to three significant figures.

[1 mark]

Amount = _____ mol

0 5 . 2 Calculate the amount, in moles, of gas produced from the sample of sodium chlorate(V) used in Question **05.1**

[1 mark]

Amount = _____ mol

Do not write outside the box

0 5 . 3 In another experiment, a different sample of sodium chlorate(V) decomposed to produce 0.563 mol of gas.

Calculate the volume, in dm^3, that this amount of gas would occupy at 303 K and 1.00×10^5 Pa.
The gas constant $R = 8.31$ J K^{-1} mol^{-1}.

[3 marks]

Volume = _____ dm^3

5

Turn over for the next question

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0 6 Calcium carbonate reacts with dilute hydrochloric acid as shown in the equation.

$$CaCO_3(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

A student added an excess of powdered calcium carbonate to 37.4 cm^3 of 0.850 mol dm^{-3} hydrochloric acid.

0 6 . 1 Calculate the amount, in moles, of HCl in 37.4 cm^3 of 0.850 mol dm^{-3} hydrochloric acid.
Give your answer to three significant figures.

[1 mark]

Amount = _____ mol

0 6 . 2 Calculate the amount, in moles, of $CaCO_3$ that reacted with the hydrochloric acid.

[1 mark]

Amount = _____ mol

0 6 . 3 Calculate the minimum mass, in grams, of $CaCO_3$ needed to react exactly with 37.4 cm^3 of 0.850 mol dm^{-3} hydrochloric acid.

[1 mark]

Mass = _____ g

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0 6 . 4 Calcium chloride is often hydrated and can be represented by the formula $CaCl_2.xH_2O$ where x is an integer.

An 8.46 g sample of $CaCl_2.xH_2O$ contains 2.07 g of water.

Calculate the value of x
Show your working.

[3 marks]

Integer value of x = _____

6

Turn over for the next question

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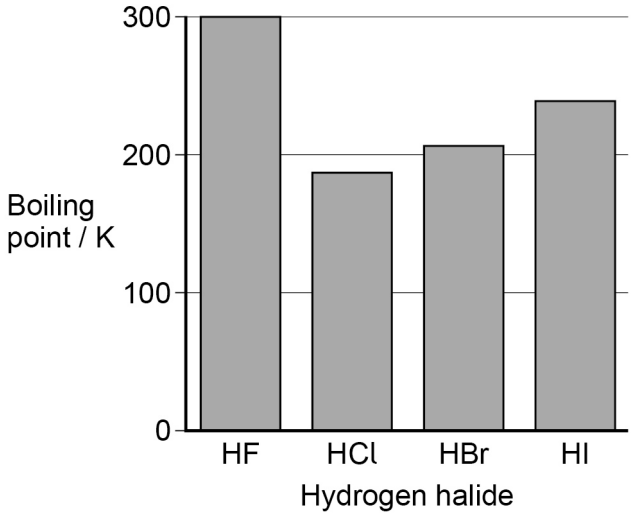
0 7 **Figure 1** shows the boiling points of the hydrogen halides, HF to HI

Figure 1



0 7 . 1 State the strongest type of intermolecular force in HI

[1 mark]

0 7 . 2 Explain why the boiling point of HF is greater than the boiling point of HCl

[2 marks]

0 7 . 3 Explain why the boiling points increase from HCl to HI

[2 marks]

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0 7 . 4 Draw a diagram to show how two molecules of HF are attracted to each other. Include all partial charges and all lone pairs of electrons in your diagram.

[3 marks]

0 7 . 5 When one molecule of a hydrogen halide dissolves in water, a reaction occurs that forms an ion with the formula H_3O^+
One of the bonds in this ion is formed in a different way from the other two bonds.

Draw a diagram of the ion, showing the two different ways of representing the bonds.

Compare the two different ways in which the H–O bonds in this ion are formed.

[4 marks]

Diagram

Comparison _____

_____

_____

_____

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0 8 This question is about the equilibrium between N_2O_4 and NO_2

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \quad \Delta H^{\ominus} = +58.1 \text{ kJ mol}^{-1}$$

0 8 . 1 A 25.2 g sample of N_2O_4 was heated in a closed flask.
At equilibrium, the mixture was found to contain 0.220 mol of NO_2

Calculate the amount, in moles, of N_2O_4 in the 25.2 g sample.
Calculate the amount, in moles, of N_2O_4 in the equilibrium mixture.
Show your working.

[3 marks]

Amount of N_2O_4 in the 25.2 g sample = _____ mol

Amount of N_2O_4 in the equilibrium mixture = _____ mol

0 8 . 2 In a different experiment, a sample of N_2O_4 was heated in a closed flask of volume 5.00 dm^3. The equilibrium mixture formed at temperature T contained 0.230 mol of N_2O_4 and 0.542 mol of NO_2

Write an expression for the equilibrium constant K_c for this reaction.
Calculate a value for K_c at temperature T and deduce its units.

[4 marks]

K_c = _____ Units _____

Do not write outside the box

0 8 . 3 A student repeated the experiment in Question **08.2** but at a temperature lower than *T*.

State and explain the effect of this lower temperature on the time taken to reach equilibrium and on the amount of NO_2 formed in the equilibrium mixture.

[6 marks]

Effect on time taken _____

Explanation _____

_____

_____

_____

Effect on amount of NO_2 _____

Explanation _____

_____

_____

_____

13

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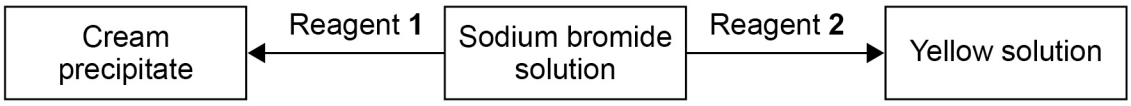
0 9 This question is about sodium bromide.

0 9 . 1 A student carried out some test-tube reactions starting with sodium bromide solution. The student recorded these observations.



Identify reagent **1** and reagent **2**.

[2 marks]

Reagent **1** _____

Reagent **2** _____

0 9 . 2 A student added a few drops of concentrated sulfuric acid to solid sodium bromide.

Give **two** observations that the student would make.
Write an ionic equation for the **redox** reaction.

[4 marks]

Observations _____

_____

_____

Ionic equation

_____

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0 9 . 3 Bromine reacts with cold aqueous sodium hydroxide in a similar way to the reaction of chlorine with cold aqueous sodium hydroxide.

Write an equation for the reaction of bromine with cold aqueous sodium hydroxide. Give the oxidation states of bromine in each of the bromine-containing products.

[3 marks]

9

END OF QUESTIONS

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